Turning Operations

Introduction

Today an Engine Lathe can be defined as a power-driven, general-purpose machine tool used for producing cylindrical work-pieces. As the piece of metal to machine is rotated in the lathe given the cutting speed motion, a single point cutting tool, provided with all the necessary cutting tool requirements such as proper tool material and proper tool angles, is given both the feed motion and the depth of cut setting. In the case of longitudinal machining the cutting tool moves along the workpiece length and in the case of facing, necking and parting off it moves laterally along its diameter. For other operations such as taper turning, the feed motion is in a resultant direction inclined to the workpiece axis by the taper angle. This relative motion removes the un-required parts in the form of chips and by using attachments and accessories other operations may be performed.

Lathes are mostly used to produce circular, conical or spherical components. **Common external lathe processes:** facing, straight turning, taper turning, threading. **Common internal lathe processes:** drilling, boring, internal straight and taper turning, countersinking, counter boring, reaming, tapping and threading.

The progress in the design of the basic engine lathe and its related machines has been responsible for the development and production of thousands of products we use every day.

Engine Lathe

Construction of the engine lathe

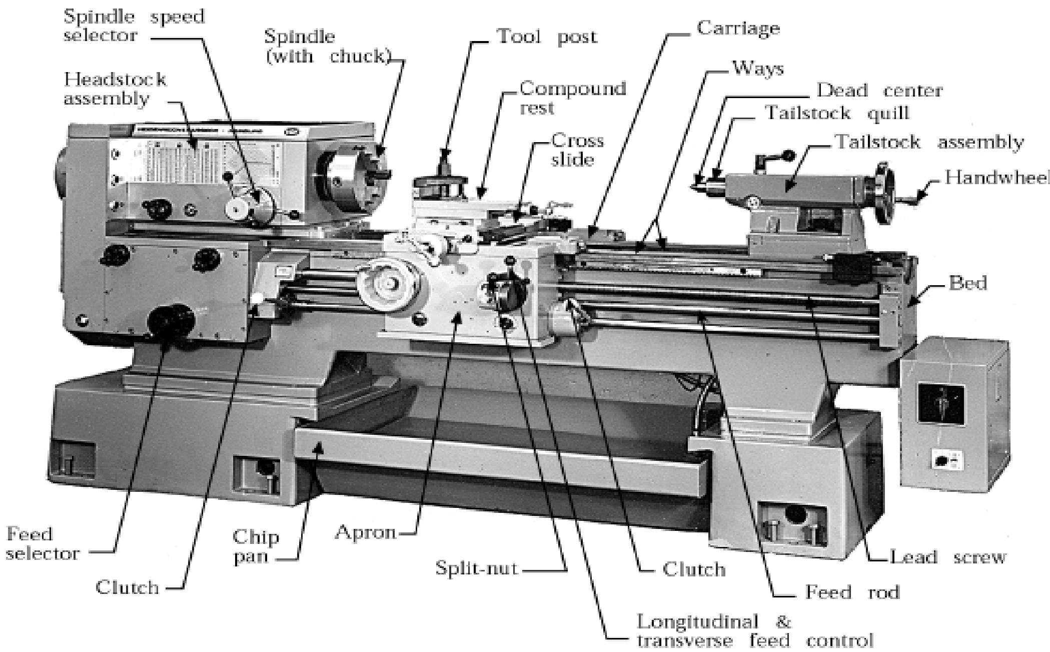


Fig.(1) Conventional and capstan lathe

Workpiece Holding Devices

The workpiece should be held tightly on the lathe to withstand the cutting forces resulted from machining its surfaces. The size and type of work to be machined and the particular operation that needs to be done will determine which work holding device is best for any particular job. Another consideration is how much accuracy is needed for a job, since some work holding devices are more accurate than others.

Five methods are commonly used for holding a workpiece in a lathe:

1. between centers,
2. in a chuck,
3. in a collet,
4. on a face plate and

5. mounted on the carriage.

In the first 4 methods the workpiece is rotated during machining, while in the 5th case, which is not used extensively, the tool rotates and the workpiece is fed into the tool.

Lathe Centers

Workpieces that are relatively long with respect to their diameters are usually machined between centers as shown in figure (2). Two lathe centers are used, one in the spindle hole, and the other in the tailstock quill. Two types are used (dead and live).

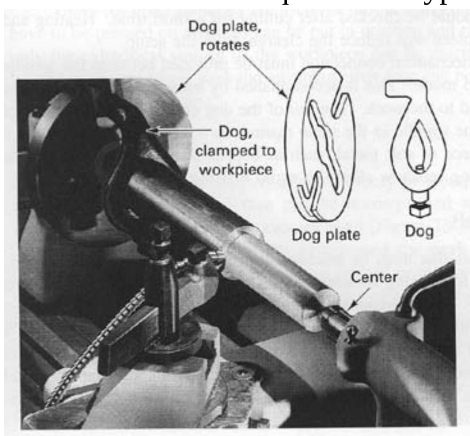


Fig.(2) Machining between centers

Dead centers are solid, that is, made of hardened steel with a Morse taper on one end, so that they fit into the spindle holes. The other end is ground to a 60° taper as shown in figure (3). Sometimes the tip of this taper is made of tungsten carbide to provide better wear resistance.

Live centers of the type shown in figure (3) are designed so that the end that fits into the workpiece is mounted on ball or roller bearings. It is free to rotate and hence no rotation is required. Live centers may not be as accurate as the solid type and therefore are not often used for precision work.

Fig.(3) dead and live centers

Before the workpiece can be mounted between the centers, a 60° center hole must be drilled in each end. A combination center and counter sink ordinarily is used. Because the workpiece and the center of the headstock end rotate together, no lubricant is needed in the center hole at this end. The center in the tailstock quill does not rotate; adequate lubrication must be provided.

A mechanical connection must be provided between the centers and the workpiece to cause it to rotate. This is accomplished by what is called the lathe dog and the dog plate as shown in figure (2). The dog is clamped to the workpiece. The tail of the dog enters a slot in the dog plate, which is attached to the lathe spindle in the same manner as the lathe chuck.

Mandrels

Workpieces that must be machined on both ends or are disk-shaped are often mounted on mandrels for machining between centers. Four common types of mandrels are shown in the figure (4).

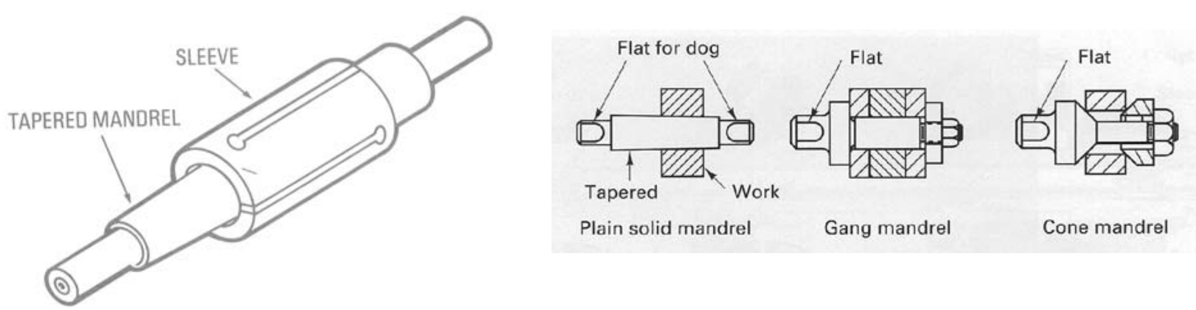


Fig.(4) different types of mandrels

Solid Mandrels usually vary from 100 – 300 mm in length and are accurately ground with a 1:2000 taper. After the workpiece is drilled or bored it is pressed on the mandrel. The mandrel should be mounted between centers so that the cutting forces tend to tighten the workpiece on the mandrel. Taper. Solid mandrels permit the work to be machined on both ends as well as on the cylindrical surface. They are available in stock sizes but can be made to any size desired.

Gang or disk mandrels are used for production work because the workpieces do not

have to be pressed on and thus can be put in position and removed more rapidly. However, only the cylindrical surface of the workpieces can be machined when using this type of mandrels.

Cone mandrels have the advantage that they can be used to center workpieces having a range of hole sizes.

Expansion mandrel It consists of a sleeve with four or more slots cut length wise fitted over a solid mandrel. A taper pin fits into the sleeve to expand it to hold work that does not have a standard size hole. An-other form of expansion mandrel has a slotted bushing fitting over a tapered mandrel. Bushings of various sizes can be used with this mandrel, increasing its range.

Lathe Chucks

Lathe chucks are used to support a wider variety of workpiece shapes and to permit more operations to be performed than can be accomplished when the work is held between centers. Different types of chucks are used as shown in figures (5).

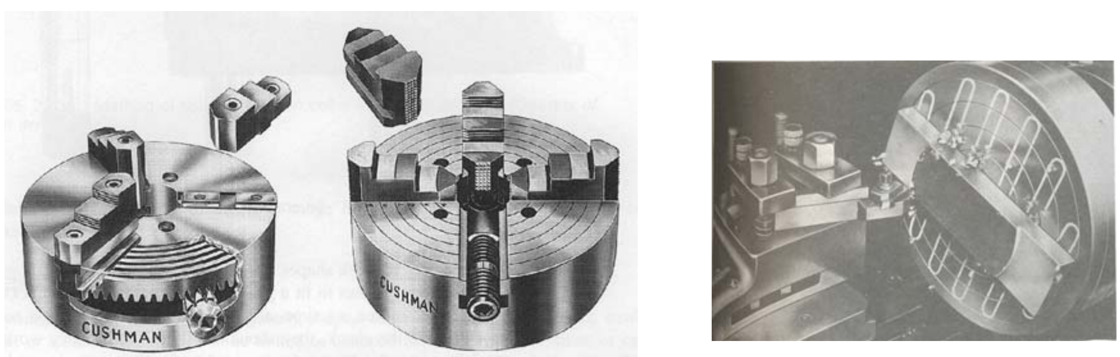


Fig.(5) 3 and 4 jaw chucks and magnetic chucks

Three jaw, self-centering chucks are used for work that has a round or hexagonal cross section. The three jaws move inward or outward simultaneously by the rotation of a spiral cam, which is operated by means of a special wrench through a bevel gear. When abused, they are considered to be less accurate.

Four-jaw independent chucks are characterized that each jaw can be moved inward or outward independent of the others by means of a chuck wrench. Thus they can be used to

support a wide variety of workpieces. A series of concentric circles engraved on the chuck face aid in adjusting the jaws to fit a given workpiece. Four-jaw chucks are heavier and more rugged than the three-jaw chucks, and they are usually used for irregular and heavy workpieces. The jaws in both types can be reversed to facilitate gripping either the inside or outside of workpieces.

Magnetic chucks are used for hold iron or steel parts that are too thin or that may be damaged if held in a conventional chuck. These chucks are fitted to an adaptor mounted on the head stock spindle. Work is held lightly for aligning purposes by turning the chuck wrench approximately one-quarter turn .After the work has been turned , the chuck is turned to the full-on position to hold the work securely. This type of chuck is used only for light cuts and for special grinding applications.

Collets

Collets are used to hold smooth cold-rolled bar stock or machined workpieces more accurately than with regular chucks. As shown in figure (6), collets are relatively thin tubular steel bushings that are split into three longitudinal segments over about two-thirds of their length. At the split end, the smooth internal surface is shaped to fit the piece of stock that is to be held. The external surface of the collet is a taper that mates with an internal taper of the collet sleeve. When the collet is pulled inward into the spindle (by means of the draw bar), the action of the two mating tapers squeezes the collet segments together, causing them to grip the workpieces as shown in figure(6).

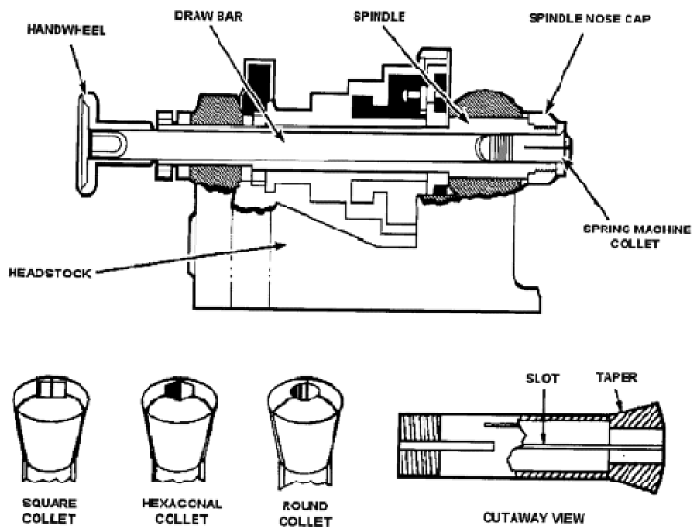
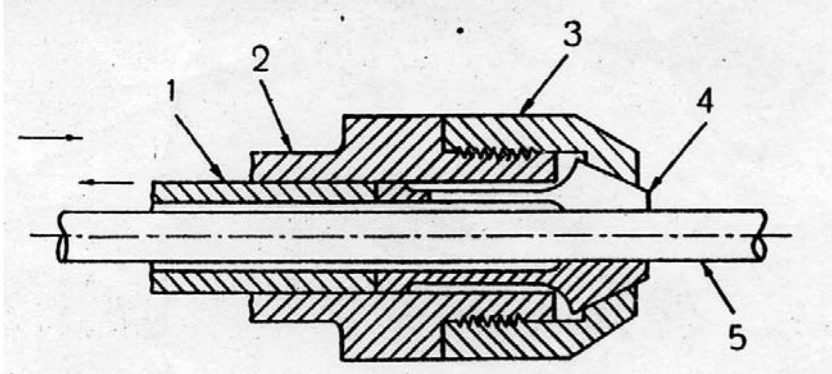


Fig.(6) collet configuration

The collets are classified according to the methods used to close the jaws on the work:

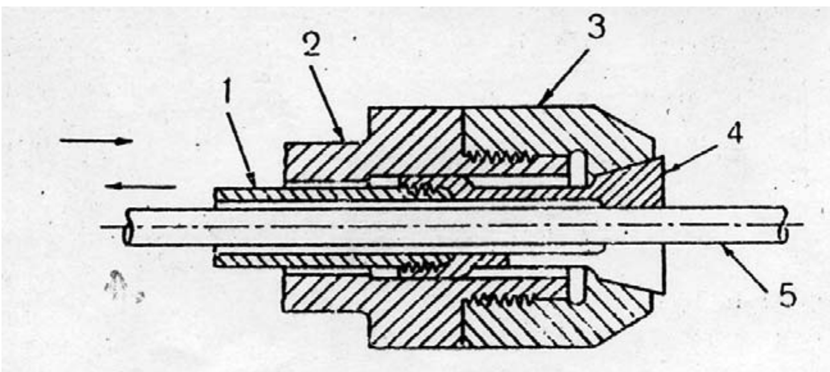
push out type: The tapered portion of the spring collet is pushed into the mating taper of the chuck. There is a tendency for the bar to be pushed slightly outward when the collet is pushed into the chuck body for gripping.



Push out type collet chuck

1. *Push tube*, 2. *Headstock spindle*, 3. *Hood*, 4. *Collet*, 5. *Bar*.

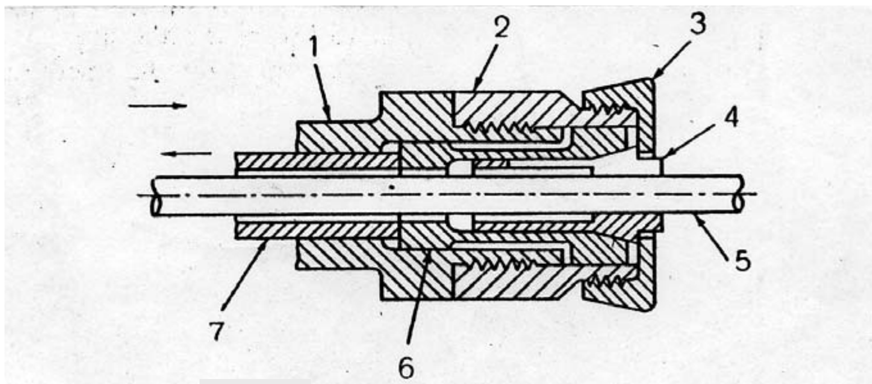
Draw in type: To grip the work, the tapered portion of the spring collet is pulled back into the mating taper of the chuck, which causes the split end of the collet to close in and grip the bar.The bar may still be drawn in slightly during the gripping operation.



Draw in type collet chuck

1. *Draw tube*, 2. *Headstock spindle*, 3. *Hood*, 4. *Collet*, 5. *Bar*.

Dead Length type: For accurate setting, a stationary collet is used. A sliding sleeve closes upon the tapered collet which is prevented from any end movement by the shoulder stop.



Dead length type collet chuck
1. ***Headstock spindle*****, 2.** ***Chuck body*****, 3.** ***Hood*****, 4.** ***Collet*****, 5.** ***Bar*****, 6.** ***Sliding sleeve*****, 7.** ***Push tube*****.**

The Jacobs collet chuck as shown in figure (7), has a wider range than the spring-collet chuck. Instead of a draw bar, it utilizes a tightening hand wheel to close the collets on the workpiece. A set of 11 rubber-flex collets, each having an adjustment range of almost 1/8in. (3mm), makes it possible to hold a wide range of work diameters. Rubber flex collets are comprised of devices made of hardened steel jaws in solid rubber housing. When the hand wheel is turned clock wise, the rubber-flex collet is forced into a taper, causing it to tighten on the workpiece. Jacob's rubber flex collets are designed for heavy duty turning and possess two to four times the grip of the conventional split steel collet.

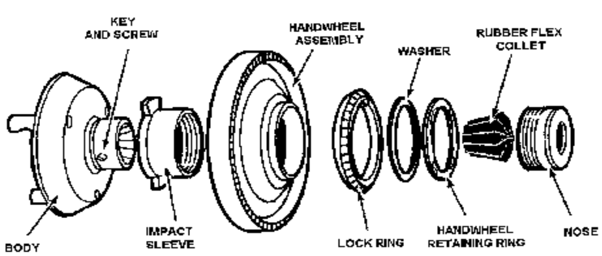
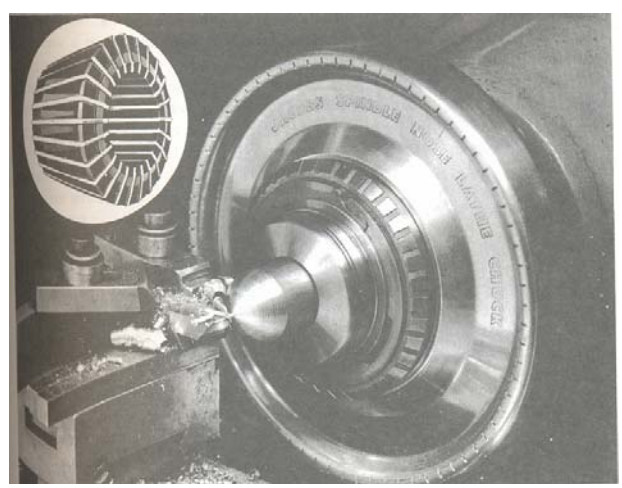


Fig.(7) Jacobs collet chuck



Faceplates

A lathe faceplate is a flat, round plate that threads to the headstock spindle of the lathe. The faceplate is used for irregularly shaped workpieces that cannot be successfully held by chucks or mounted between centers. The workpiece is either attached to the faceplate using angle plates or brackets or bolted directly to the plate. Radial T-slots in the faceplate surface facilitate mounting workpieces. The faceplate is valuable for mounting workpieces in which an eccentric hole or projection is to be machined. A small faceplate known as a driving faceplate is used to drive the lathe dog for workpieces mounted between centers.

The driving faceplate usually has fewer T-slots than the larger faceplates. When the workpiece is supported between centers, a lathe dog is fastened to the workpiece and engaged in a slot of the driving faceplate.

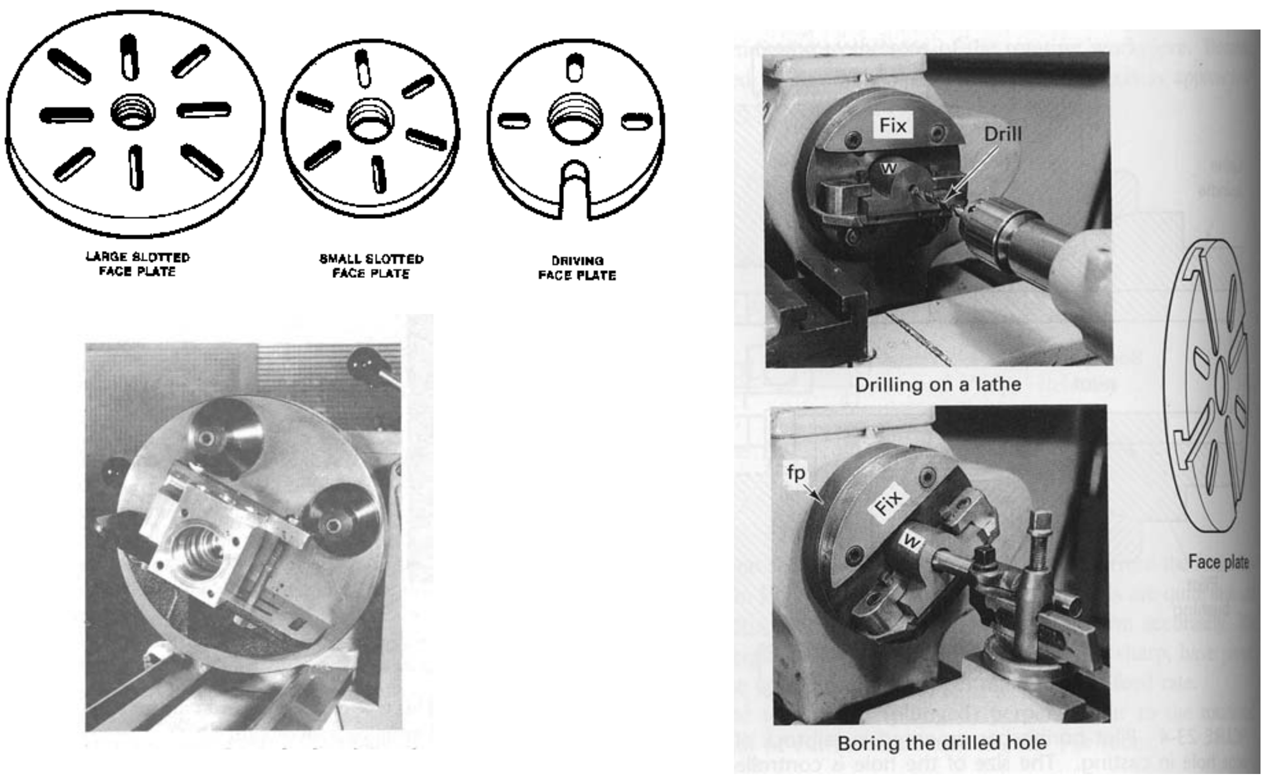


Fig.(8) Faceplates

Mounting work on the carriage

When no other means is available, boring occasionally is done on a lathe by mounting the work on the carriage, with the boring bar mounted between centers and driven by means of a dog.

Steady and follow rests

If one attempts to turn a long, slender piece between centers, the radial force exerted by the cutting tool, or the weight of the workpiece itself, may cause it to be deflected out of line. *Steady rests and follow resets* provide means for supporting such work between the headstock and the tailstock. The steady rest is clamped to the lathe ways and has three movable fingers that are adjusted to contact the workpiece and align it. A light cut should be taken before adjusting the fingers to provide a smooth contact-surface area. A steady rest can be also used in place pf the tailstock as a means for supporting long workpieces, workpieces having a large internal hole to permit using a regular dead center or work where the end must be open for boring.

The follow rest is bolted to the lathe carriage. It has two contact fingers that are adjusted to bear against the workpiece, opposite the cutting tool, to prevent the work from being deflected away from the cutting tool by the cutting forces as shown in figure (9).

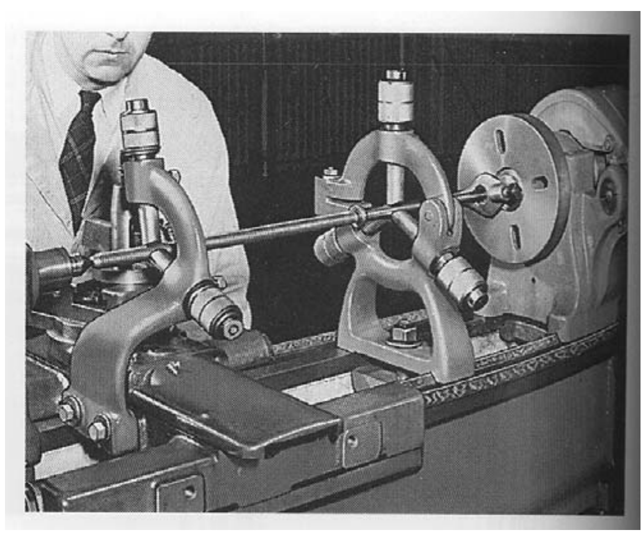


Fig.(9) Steady and Follow rest

Tool Holding Devices

Tool holders are fixtures and devices used for holding cutting tools securely. Lathe cutting tools are generally held by 2 methods:

Tool holders: This provides a mean of rigidly holding the cutting tool. The most common tool holders are those used for turning, threading cutting-off and boring operations.

Tool posts: This provides a mean of holding either the tool holder or the cutting tool. The most common are the standard, turret, heavy duty and the quick change tool posts.

Tool holders for high-speed steel tool bits

Tool holders of high-speed steel tool bits are manufactured in three styles:

The left-hand offset tool holder as shown in figure (10-a) is used for machining work close to the headstock, facing operations and cutting from right to left.

The straight tool holder as shown in figure (10-c) is used for taking cuts in either direction. It is a general purpose tool holder.

The right-hand offset tool holder as shown in figure (10-b) is used for machining work close to the tailstock, facing operations and cutting from left to right.

All tool holders of this type accommodate square tool bits, ranging from 5 to 20 mm. square, which are held in place by a set screw on the top of the tool holder. The square hole which accommodates the tool bits is at an angle of 15 to 20 degree to the base of the tool holder. This provides the proper back rake for high speed steel tool bits when machining on a lathe.

Fig. (10) Common lathe toolholders: (a) left-hand offset (b) right-hand offset; (c) straight

Toolholders for brazed carbide tipped tool bits

Tool holders of this type are similar to those used for high speed steel tool bits. They are available in 5 sizes to accept tool bits shank from 6 to 16 mm square. the hole in the tool holder is parallel to the base. They are available in straight, right-hand and left-hand offset as shown in figure (11).

Fig. (11) Carbide tool holders hold the tool bit parallel to the base of the holder

Cutting-off tool holders

A cutting-off or parting tool is generally used when work is to be parted off, grooved or undercut. Parting tools are long, thin blade with suitable side clearance to prevent them from binding when in use. They are held tightly in place by means of a cam or wedging action provided in the tool holder. Cutting-off tool holders may be of the solid type or the spring type.

Solid type tool holders are available in straight, right-hand offset and left-hand offset shanks as shown in figure (12).

Fig. (12)-types of solid cutting off tool holders: (a) left-hand , (b) straight , (c) right-hand

Spring type tool holders are designed to relieve excess pressure on the cutting blade. The gooseneck design of the holder reduces cutting tool chatter and minimizes tool

breakage caused when work climbs onto the cutting tool. Spring-type tool holders are made with straight and right hand shanks as shown in figure (13).

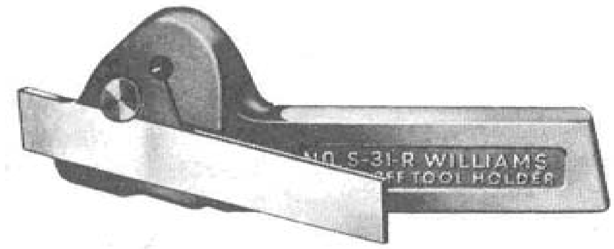


Fig. (13) Spring-type tool holders reduce the chances of broken tools and damaged work during cutting-off operations

Threading Tool holders

Threading in a lathe is generally performed by holding a toolbit, ground to the desired thread form, in a tool holder. A special tool holder with a cam shaped cutter ground to 60 degree is available for thread cutting, as shown in figure (14). The cutter is form-relieved and should be ground only on the top face when sharpening is required. The tool height is adjustable, after the height has been set; the tool is then locked in position.

Fig. (14) A performed thread cutting tool and tool holder

Boring tool holders

Boring tool holders are made in several styles to accommodate the wide range of internal machining which can be performed on a lathe. Light boring tool holders as shown in figure (15-A) are held in the tool post and are used for small holes and light cuts. Boring tools are generally made of round stocks with forged ends. They may be ground for boring or internal threading as required. A boring tool suitable for heavier work as shown in figure (15-B) is held in the tool post. This consists of a boring bar held

in tool holder and a tool bit fitted into the end of the boring bar. Boring bars generally allow tool bits to be held at 45 or 90 degrees to the axis of the bar.

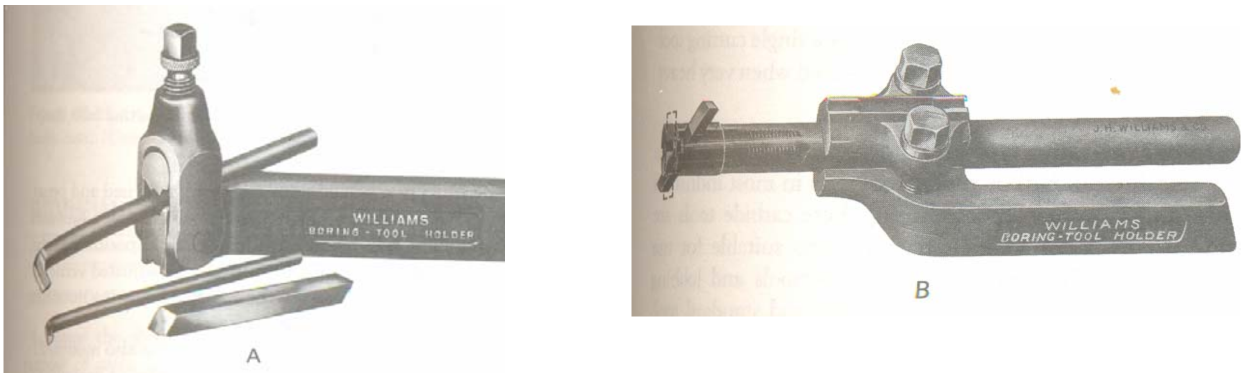


Fig. (15) Boring tool holders

Standard (round) tool post:

This tool post, which fits into the T-slot of the compound rest, provides a means of holding and adjusting a tool holder or a cutting tool, figure (16).

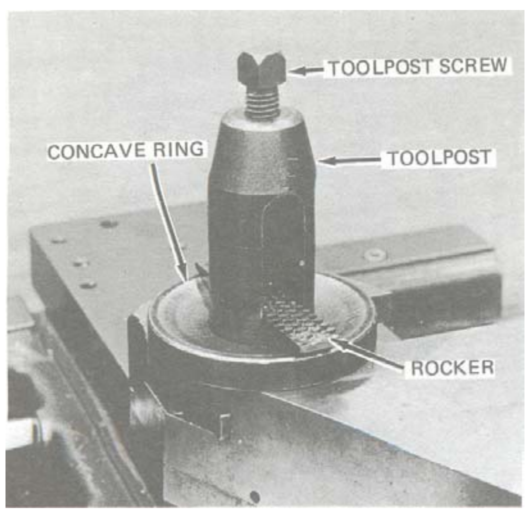


Fig (16) a standard tool post

Square turret tool post

They are designed to hold 4 cutting tools, which can be easily indexed for use as required as shown in figure (17). Several operations, such as turning, grooving, threading

and parting-off may be performed on a workpiece by loosening the locking handle and rotating the holder until the desired tool is in the cutting position. This reduces the setting time for the various tools, thereby increasing production. This tool post fits into the slot in the compound rest, and is designed for the use with solid type tools and tool holders for throwaway carbide inserts.

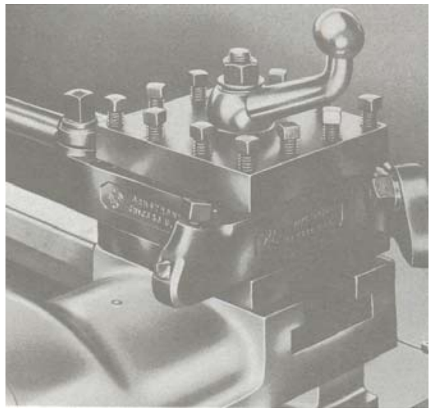


Fig. (17) A turret type tool post permits the use of up to 4 different cutting tools

As illustrated in figure (18), the turret can be indexed through 90 degrees and re-clamped in the new position with a single lever 2. When the lever is turned in direction (a), shaped nut 1 first releases the turret and then tooth 4 engages one of the spring-loaded pins 5 and indexes the turret. Locking pin 3 properly locates the turret in each position. When lever 2 is turned in the other direction (b) the turret is re-clamped on the tool slide and the tooth of the nut slips over the next pin, thereby preparing the turret for the next indexing

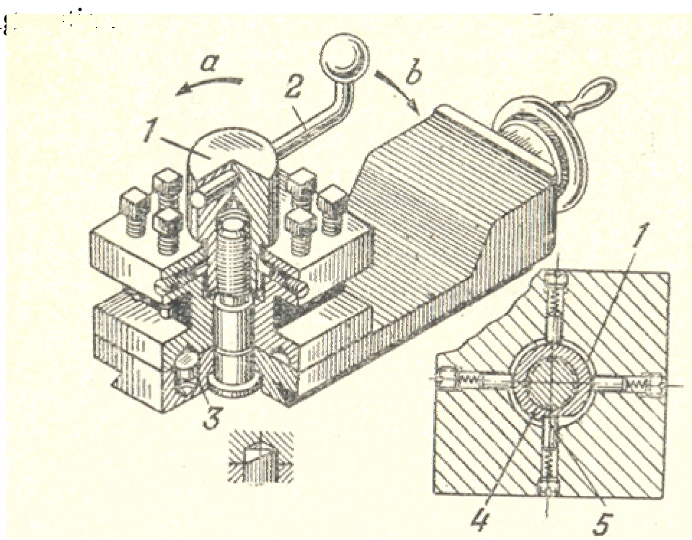


Fig. (18) square turret

Quick change tool post and holders

Quick-change tool holders with interchangeable holding members permit the lathe to be equipped with a great variety of tools whose setting up requires a minimum loss in time. Each holder is dovetailed and fits on a dovetailed tool post, which is mounted on a compound rest as shown in figure(19).

One construction of a quick-change toolholder is illustrated in figure (20).

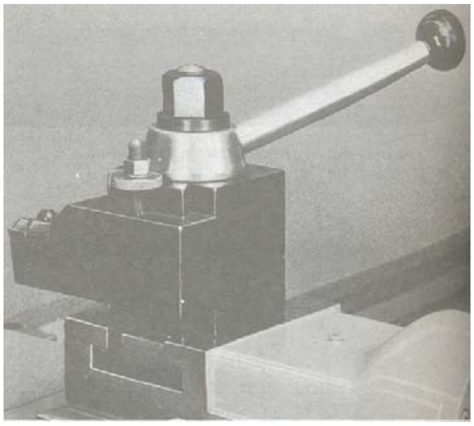


Fig. (19) Quick change tool holder

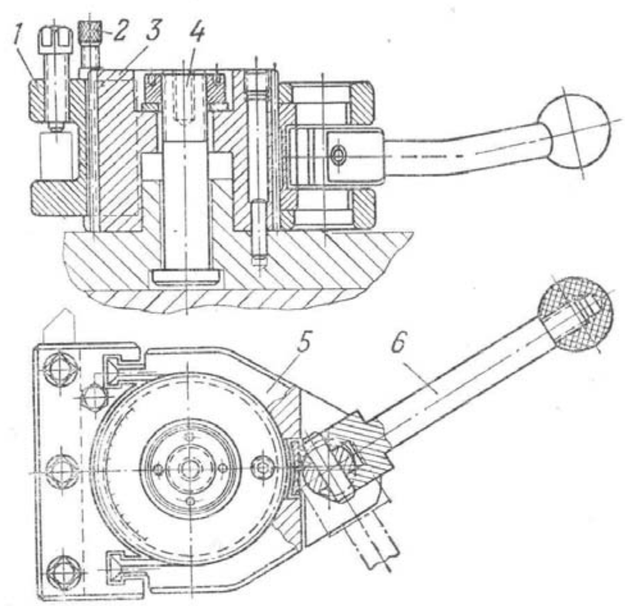


Fig. (20) Quick change tool holder construction

The wide gear 3 is mounted on the compound rest of the lathe and secured by bolt 4, a nut and a dowel pin. The interchangeable holding member 1 has internal gear teeth cut on one side which fits the tooth spaces of gear 3. Yoke 5 serves to clamp the holding members; its T-shaped lugs enter T- slots in the holding members. With the aid of eccentric-action lever 6 the holding member is securely clamped to the gear. The tool is adjusted in height by means of screw 2.

Heavy duty tool post

It is also mounted in the slot of the compound rest. It is designed basically for use with carbide cutting tools and holds a single cutting tool or tool holder. This type of toolpost is used when very heavy cuts are required as shown in figure (21).

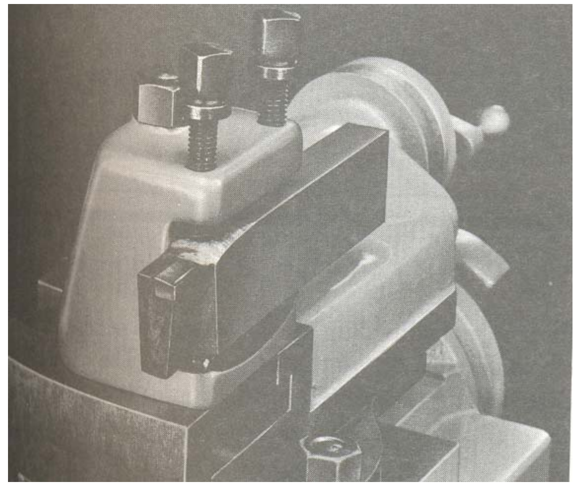


Fig. (21) Heavy duty tool post

Capstan and Turret Lathes

Introduction:

The capstan or turret lathes are production lathes used to manufacture any number of identical pieces in the minimum time. These machines are a development of the conventional engine lathes. The capstan lathe was first introduced in the USA by Pratt and Whitney in the 1860s.

The capstan or turret lathe consists of a bed, all geared headstock, and a saddle on which a 4 station tool post is mounted to hold 4 different tools. A tool post fitted at the rear of the carriage hold a parting-off tool at an inverted position. The tool post mounted on the cross slide is indexed by hand. In a capstan or turret lathe there is no tailstock, but instead a hexagonal turret is mounted on a slide which rests upon the bed. All the six faces of the turret can hold six or even more different tools. The turret may be indexed automatically and each tool may be brought inline with the lathe axis in a regular sequence. The workpieces are held in collets or chucks. The longitudinal feed movement of the turret is regulated by adjustable stops. These stops enable different tools set at different stations to move by a predetermined amount for performing different operations on repetitive workpieces without measuring the length or diameter of the machined

surface in each case. These special features of a capstan or turret lathe enables it to perform a series of operations such as turning, drilling, boring, thread cutting, reaming, chamfering, parting-off and many other operations in a regular sequence to produce a large number of identical pieces in the minimum time.

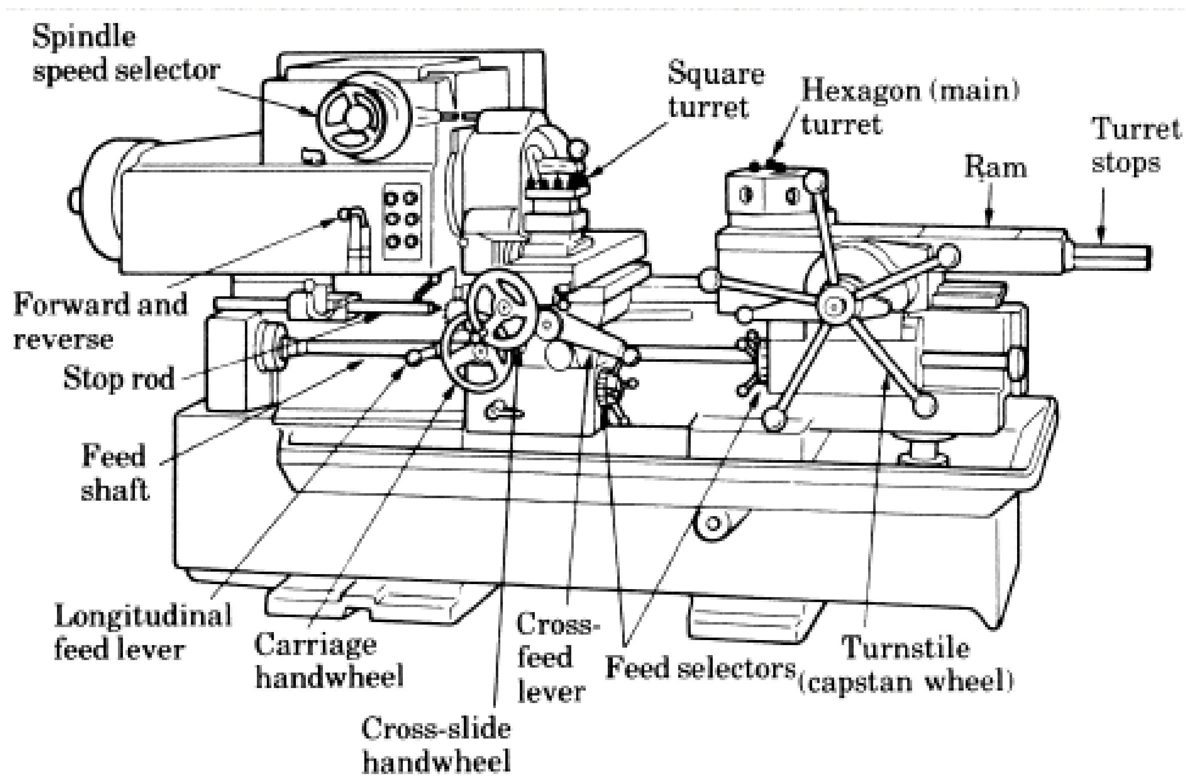


Fig. (22) Capstan Lathe

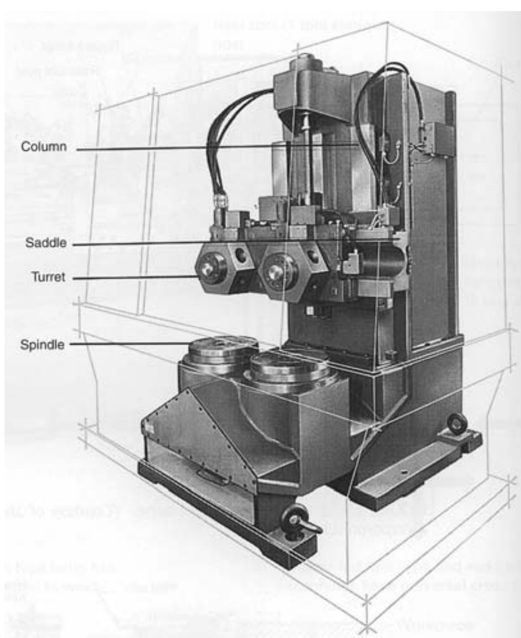


Fig. (23) Twin-spindle vertical turret lathe

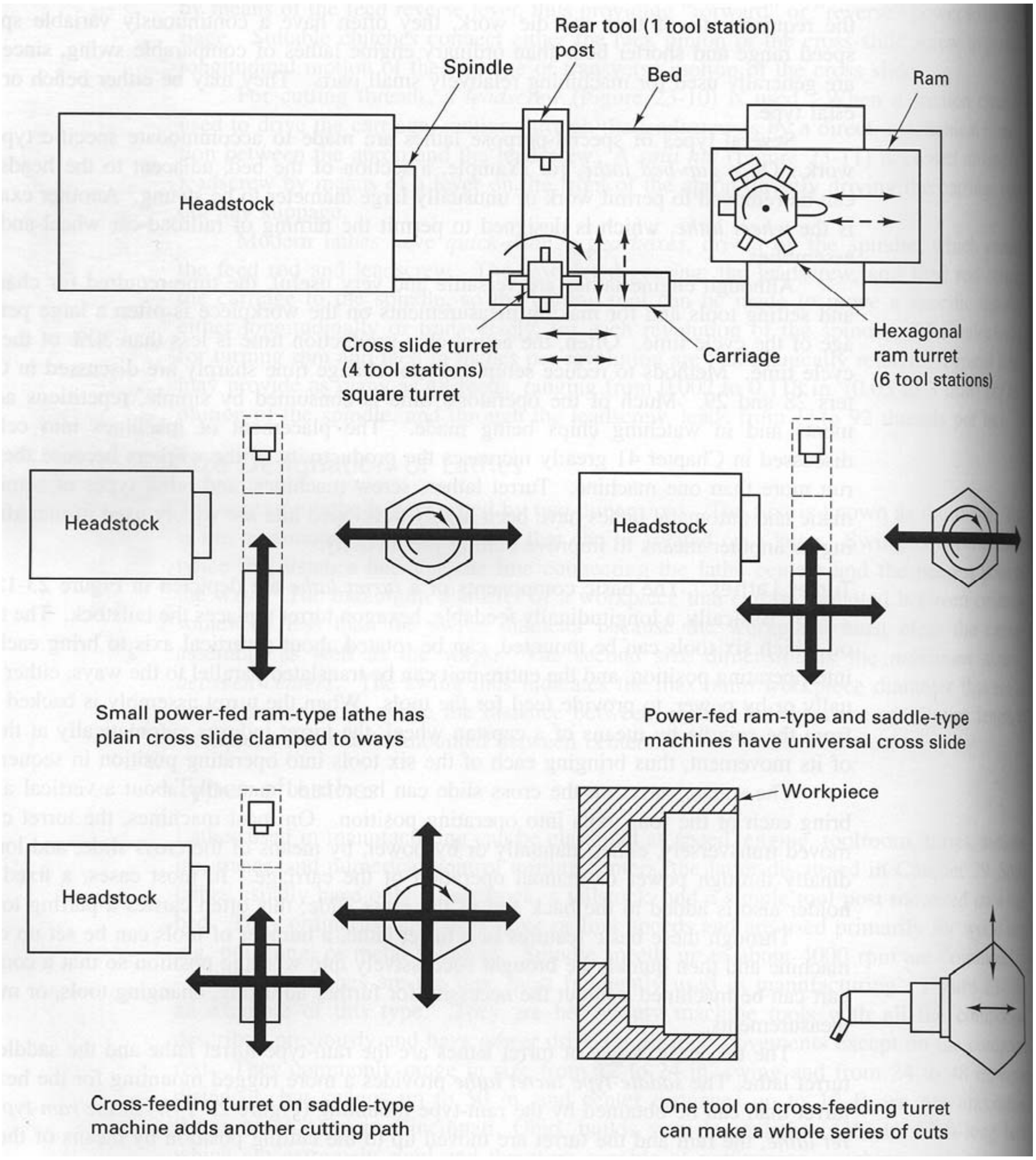
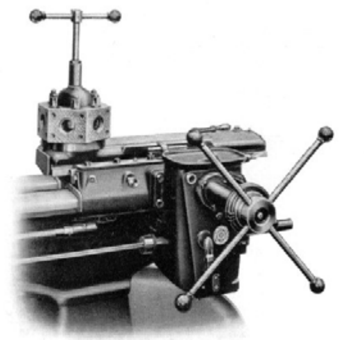
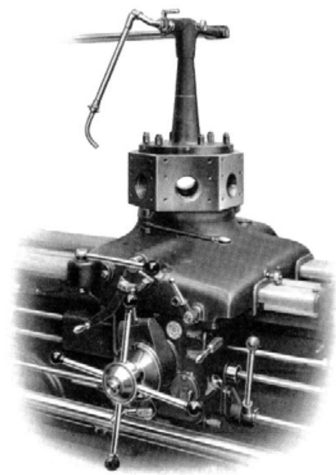


Fig. (24) Block diagram for a capstan lathe

Differences between the capstan – turret lathes and a conventional engine lathe

	Capstan – Turret Lathes	Conventional Engine Lathe
Headstock	• Lower range of speeds. • Higher horsepower	• Wider range of speeds • Lower horsepower
Tool post	• Holds 4 tools indexed by 90°. • Rear tool post for parting off (capstan lathe)	• Can hold up to 4 tools but usually only one is used and replaced upon request.
Tailstock	• Replaced by a turret	• Regular tailstock
The feed movement	• Feed for each tool on the turret is regulated by stops and feed trips.	• Feed distance is regulated manually
Combination cuts	• More than one tool can be mounted on each face of the turret to perform combined cuts.	• uncommon
Labor cost	• Skilled operator is required to setup the capstan or turret lathes. • Less skilled operators are required to operate the machine tool	• Usually a skilled operator is required to operate the engine lathe.
Production scheme	• Batch or mass production scheme	• Single or odd production scheme

Differences between the capstan and the turret lathes

	Capstan	Turret Lathe
Turret position and Movement	• The turret is mounted on a short slide or ram that slides on the saddle. • The saddle is clamped to the bed ways after adjusting the length of the workpiece. • Travel of the turret is dependent on the travel of the ram. • Limits the length of the workpiece to be machined in one operation. 	• The turret is mounted on a saddle which slides directly on the bed. • Can move the entire length of the bed. • Can machine longer workpieces. 
Rigidity	• Less rigid • Size up to 60mm diameter	• More rigid. • Size up to 200mm diameter
Workpiece type	• Suitable for bar work	• Larger and heavier chucking workpieces
Workpiece size	• Turret moves easier and faster and hence suitable for small parts that require light and fast cuts.	• Turret is heavier to move. Suitable for larger and heavier cuts.
Workpiece clamping	• Equipped with bar feeding mechanism or regular chucks or collets.	• May be equipped which pneumatic chucks.

Principal parts of capstan and turret lathes

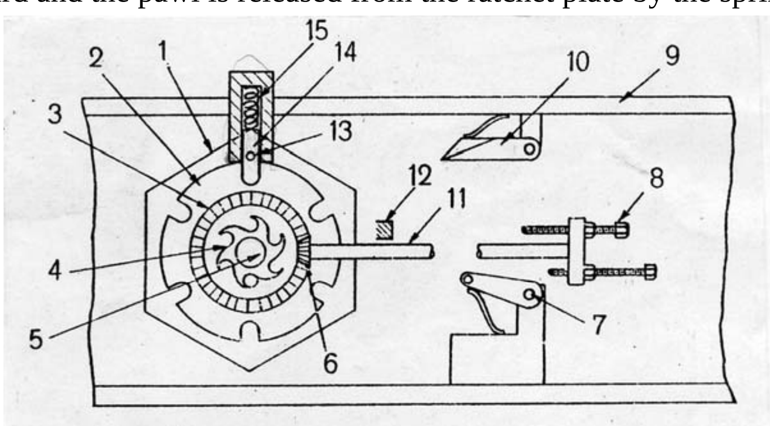
The turret lath contains essentially the same parts as the engine lathe except the turret and a complex mechanism incorporated in it to make it suitable for mass production. The following figures show the essential parts of the capstan and turret lathes.

The principal parts are:

1. **Bed:** The bed is a long box-like casting provided with accurate guide ways upon which the carriage and turret saddle are mounted. It is designed to ensure strength, rigidity proper alignment under heavy duty services.
2. **Headstock:** The headstock is a large casting located at the left hand end of the bed. The types of the headstock are as follows:
    a. **Direct Electric Motor** The spindle of the machine and the armature of the motor are directly connected. Changing the speed is enabled by varying the motor speed electrically.
    b. **All-geared Headstock** The spindle of the machine is geared-connected to the motor and different mechanisms are employed for changing the speed by actuating levers.
3. **Turret saddle and auxiliary slide:** In a capstan lathe, the turret saddle bridges the gap between two bed ways, and the top face is accurately machined to provide bearing surface for the auxiliary slide. The turret saddle may be adjusted on the guide ways and clamped at the required position. The hexagonal turret is mounted on the auxiliary slide. In the turret lathe, the turret is directly mounted on the top of the saddle and any movement of the turret is affected by the movement of the saddle. The turret is a hexagonal shaped tool holder intended for holding six or more tools. Each face of the turret is accurately machined. Through the center of each face, accurately bored holes are provided to accommodate for shanks of different tools. The center line of each hole is aligned with the axis of the lathe spindle. There are 4 tapped holes for securing different tool holding attachments. At the center of the top surface of the turret there is a clamping lever to lock the turret on the saddle. Six stop bars are mounted on the saddle which restrict the movement of each tool mounted on each face of the turret to be fed to a

predetermined amount. After one operation is completed, as the turret is brought back away from the spindle nose, the turret indexes automatically by a mechanism incorporated on the bed and in turret saddle, so that the tool mounted on the next face is aligned with the work.

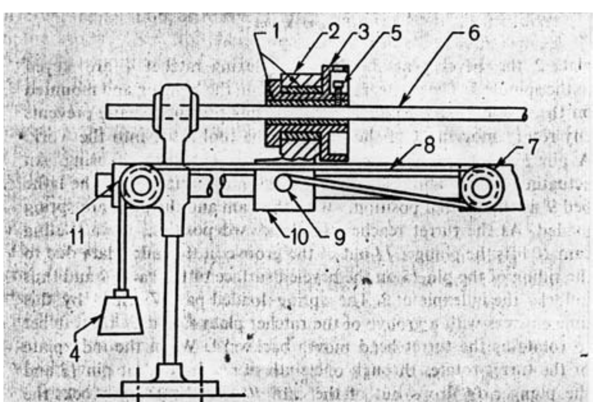
4. **Turret Indexing Mechanism:** A simple schematic of the mechanism is shown in the following figure. The turret (1) is mounted on the spindle (5), which rests on a bearing on the turret saddle (not shown in figure). The index plate (2), the bevel gear (3) and the indexing ratchet (4) are keyed to the spindle (5). The plunger (14) fitted within the housing and mounted on the saddle locks the index plate by spring pressure (15) and prevents any rotary movement of the turret as the tool feeds into the part. A pin (13) fitted on the plunger (14) projects out of the housing. An actuating cam (10) and the indexing pawl (7) are attached to the lathe bed (9) at the required position. Both the cam and pawl are spring loaded. As the turret reaches the backward position, the actuating cam (10) lifts the plunger (14)out of the groove in the index plate due to the riding of the pin (13) on the beveled surface of the cam (10) unlocking the index plate (2). The spring loaded pawl (7), which by this time engages with a groove of the ratchet plate (4), causese the ratchet to rotate as the turret head moves backward. When the index plate or the turret rotates by one sixth of a revolution, the pin (13) and the plunger (14) drops out of the cam (10) and the plunger locks the index plate in the next groove. The turret is thus indexed by one sixth of the revolution and again locked in the new position automatically. The turret holding the next tool is now fed forward and the pawl is released from the ratchet plate by the spring pressure.



Turret indexing mechanism

1. *Hexagonal turret*, 2. *Index plate*, 3. *Bevel gear* 4. *Indexing ratchet*, 5. *Turret spindle*, 6. *Bevel pinion*, 7. *Indexing pawl*, 8. *Screw stop rods*, 9. *Lathe bed*, 10. *Plunger actuating cam*, 11. *Pinion shaft*, 12. *Stop*, 13. *Plunger pin*, 14, *Plunger*, 15. *Plunger spring*.

5. **The synchronized movement of the stop rods:** This is also illustrated in the same figure. The bevel pinion (6) meshes with the bevel gear (3) mounted on the turret spindle. The extension of the pinion shaft carries a plate holding six adjustable stop rods (8). As the turret rotates through one sixth of a revolution, the bevel gear (3) causes the plate to rotate.
6. **Bar feeding mechanism:** The capstan and turret lathes, while working on bar work require some mechanism for bar feeding. The long bars which protrude out of the headstock spindle require to be fed through the spindle up to the bar stop after the first piece is completed and the collet chuck is opened. It may be pushed by hand but it requires long time for stopping the machine and feeding the bar. Therefore various types of bar feeding mechanisms have been designed, which pushes the bar forward immediately after the collet releases the work without stopping the machine. The following figure illustrates a simple bar feeding mechanism. The bar (6) is passed through the bar chuck (3) of the machine and then through the collet chuck. The bar chuck (3) rotates in the sliding bracket body (2), which is mounted on a long slide bar. The bar chuck (3) gripps on the bar by 2 set screws (5) and rotates with the bar in the sliding bracket body (2). One end of the chain (8) is connected to the pin (9) fitted on the sliding bracket (10) and the other end supports a weight (4). The chain is running over 2 fixed pulleys (7) and (11) mounted on the slide bar. The weight (4) constantly exerts end thrust on the bar chuck while it revolves on the sliding bracket and forces the bar through the spindle, the moment the collet chuck is released. Thus bar feeding may be accomplished without stopping the machine.



Bar feeding mechanism

1. *Chuck bush*, 2. *Sliding bracket body*, 3. *Bar chuck*, 4. *Weight*, 5. *Bar chuck set screw*, 6. *Bar*, 7, 11. *Pulley*, 8. *Chain*, 9. *Pin on the sliding bracket*, 10. *Sliding bracket.*

7. **Work holding Devices:** The standard practice of holding work between two centers in an engine lathe finds no place in capstan or turret lathes. Workpieces is therefore supported at the spindle end using chucks of fixtures. The usual methods used in capstan or turret lathes for holding the workpiece are as follows:
    a. **Jaw chucks:** The jaw chucks used are the ones having 3 or 4 jaws. They are used to support odd sized or large diameter jobs.
        i. **Self centering chucks,**
        ii. **4 jaw independent chucks,**
        iii. **Power operated chucks,**
        iv. **Collet chucks:** The collet chucks are used for gripping bars introduced through the headstock spindle and is one of the most common methods for holding work. They are much more suitable for holding work than the self-centering chucks in mass production due to its quickness and accuracy in setting. Different sizes of spring collets having square, hexagonal and round shaped bore are fitted in the chuck body for holding different sizes of bars having different shapes. The collets are classified according to the methods used to close the jaws on the work to *push out type, draw-in type and dead length type* as described earlier.

Capstan or turret lathe tools

The different type of tools mounted on tool holders on the cross slide and on the turret are similar to that of the center lathe, except for few differences to allow for higher productivity. The different operations performed on the capstan and turret lathes are:

1. turning,
2. facing,
3. parting off,
4. chamfering,
5. work stop,
6. grooving and recessing,
7. forming,

8. drilling,
9. boring,
10. counterboring,
11. reaming,
12. external thread cutting,
13. internal thread cutting

The main differences between the applications of the capstan and turret lathe are in the following applications:

1. thread cutting,
2. compound cutting by using more than one cutting tool in a single stroke,
3. workpiece support during the machining operation.

Thread cutting

Two types of external thread cutters are implemented in the capstan and turret lathes, which are using either *solid button dies* or *chasers*.

Solid button die figure (25): the button die is actually an adjustable split nut in which teeth have been machined and hardened to provide cutting edges. The cutting edges are pressed on the work by tightening the body of the die by two set screws. The pressure can be released by allowing a third screw to enter into the split portion to expand. As the die is nonreleasing type, it must be backed off after the thread is cut by reversing the machine spindle. Button dies can cut thread close to the shoulder of the work.

Chasers figure (26): all self opening die holders are fitted with four chasers for cutting a thread. The chasers are considered to be forming tools which are equally spaced on the circumference of the workpiece. The shape and pitch of the cutting edges of the chaser conform to the shape and pitch of the thread being cut. The chasers are superior to the solid dies due to the following reasons:

1. The chaser not being a solid unit can open up the end of the cut by the mechanism incorporated in the self opening die head. This permits the quick removal of the die head from the work.
2. The chaser may be separately removed and reground with ease.

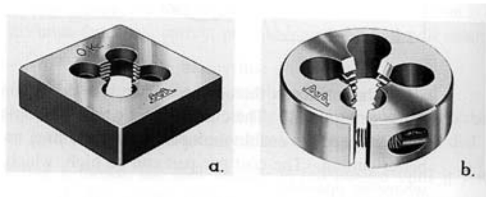


Fig.(25) solid die set
Fig.(25) solid die set

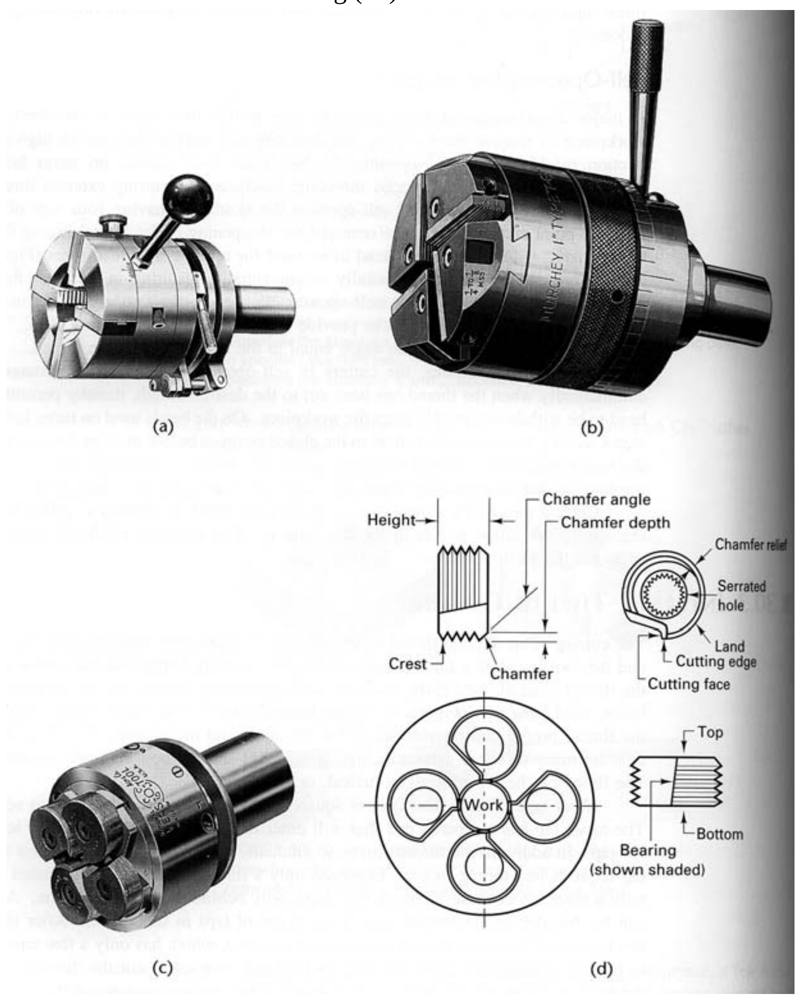


Fig.(26) Radial, tangential and circular chasers with their proper die head

workpiece support:

One feature of construction common to all turret lathes is the absence of the tailstock. Consequently the workpiece overhang can become a problem. As the unsupported length increases, the difficulty in controlling dimensions increases, along with the possibility of the workpiece will climb on the tool. The amount of unsupported

length that can be tolerated depends greatly on the operations being performed. For cross-slide operations such as form turning, an unsupported length of about 3.5 times the diameter is usually the recommended maximum.

Natural supports: Sometimes, a sequence of operations to be performed can be planned such that the workpiece is provided with natural support from the tools. For example, it may be possible to perform simultaneous operations with axially and radially mounted tools; in this case, a drill provides a measure of support while form tuning is accomplished from the cross-slide. Cutting simultaneously from 2 or more cross-slides is another method by which sufficient support is achieved by natural means. Usually, however, where unsupported workpiece length is equal to several multiples of the diameter, some special means of support must be provided when the outside diameter of the workpiece is machined.

Roller supports as shown in figure (27) are frequently used when workpiece overhung is excessive. Usual practice is to mount such a device on a cross-slide opposite the direction of the cutting forces; this prevents bending of the workpiece during machining. As seen in the figure, the rollers can be adjusted to accommodate a range of workpiece diameters. Supports similar to the type shown in that, in which the workpiece is supported in a V-slot instead of the rollers, have also been successively used, but roller supports are preferable.

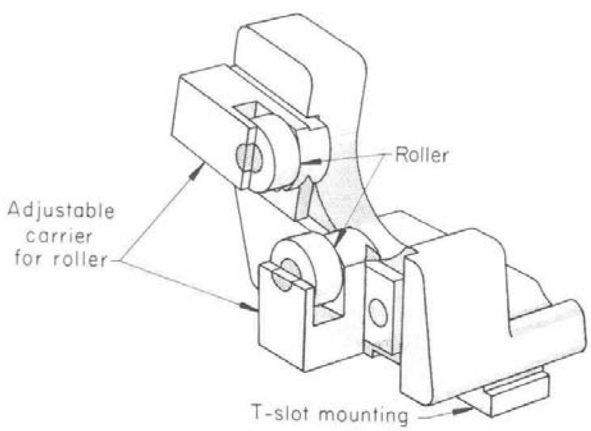


Fig.(27) roller support used to prevent the workpiece from bending during machining

Box tools: Tools used for this procedure combine support with one or more cutting tools. Tools that incorporate both support and cutters are often called box tools and are made in a variety of designs and size. A box tool that incorporates 2 supporting rollers and one cutting edge is illustrated in figure (28).

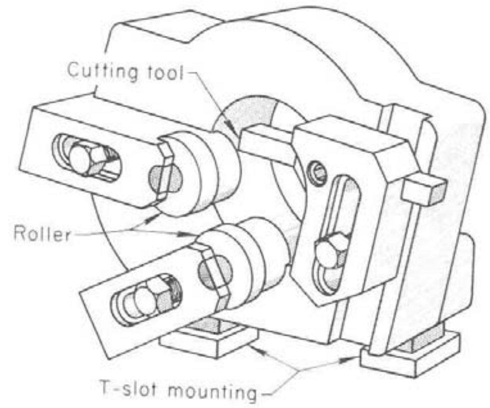


Fig. (28) box tool with rollers for support of the workpiece during axial turning

In turning with this type of tool, the rotating workpiece passes between the rollers and the cutter. The cutter is set slightly ahead of the rollers, which allows the rollers to begin their function of providing support as turning progresses.